Mariner of the Nebulae
An opera

Reuben Thomas

Cast of Characters

Edwin Hubble	Astronomer at Mt Wilson, Baritone
Grace Burke Hubble	Edwin Hubble's wife and biographer, Soprano
Albert Einstein	Physicist at large, Tenor
Henrietta Leavitt	Astronomer and computer at Harvard, Mezzo-soprano
Georges Lemaître	Priest and physicist, Tenor
Harlow Shapley	Astronomer at Mt Wilson, Tenor
Walter Adams	Solar astronomer at Mt Wilson, Baritone
Heber Curtis	Astronomer at Lick Observatory, Bass
George Ellery Hale	Solar astronomer at Mt Wilson and fund-raiser, Bass
Milton Humason	Astronomer and technician at Mt Wilson, Bass-baritone
Adriaan van Maanen	Astronomer at Mt Wilson, Countertenor
Richard Tolman	Physicist at Caltech, Baritone
Elsa Einstein	Albert Einstein's wife, Contralto
Chorus	of astronomers, computers, ramblers, technicians, diners, correspondents, and stars
Williamina Fleming	Astronomer and computer at Harvard, Soprano
Annie Jump Cannon	Astronomer and computer at Harvard, Alto
President of the Royal Astronomical Society Dining Club	Bass
Journalist	High voice
Hugo Benioff	Student Astronomer, Tenor
Athanæum Diner	High voice

CHORUS

O you, that on your loftier mountain dwell
And move like light in light among the thoughts
Of heaven, translating our mortality
Into immortal song, is there not one
Among you that can turn to music now
This long dark fight for truth?

Scene 1

(1st November 1917. The 100" Hooker telescope observatory dome, on Mt Wilson. Night. The ailing Director Hale and his deputy Adams prepare to ascend the stairs to the observing platform. Chorus of technicians.)

Adams

The Hooker hundred inch!
Ten years in the making:
The glass cast in France, at the great glassworks of St Gobain,
Shipped across the Atlantic,
The most valuable merchandise ever to be shipped across the Atlantic
It arrived in Pasadena—
And Ritchey
The irascible Ritchey
Declared it useless!
Useless!
Air bubbles in the glass made it weak and useless, he said!
So St Gobain tried again, and again, but the glass broke each time.
Two years we waited

(to Hale)

—my poor friend—
Until it saw the light of Day—Arthur Day of the Corning Glass Company—
Who showed the bubbles made the glass stronger—stronger!
So for five years it was ground and polished,
Ground and polished,
And the dome was built:
100 tons of cement! 600 tons of sheet metal!
The telescope rests on steel floats in tanks of liquid mercury
So it turns at the touch of a hand!

(Aside)

But will it work?

(An assistant pushes buttons to position the machinery: the observing platform rises and rotates, the slit in the dome counter-rotates, and the telescope turns to lock on to its target. Adams and Hale climb to the platform. Hale looks through the eyepiece briefly, and turns to Adams, appalled. Adams looks through the eyepiece in his turn.)

ADAMS

Six Jupiters! Six Jupiters!

HALE

Ritchey was right—it's useless!

ADAMS

Wait! The dome has been open all day under the hot sun—maybe it has warped the mirror. We only have to wait for it to cool down. Cool down!

(They each look through the eyepiece once more.)

ADAMS

We'll go to bed and look again at 3 a.m.

(Exit Hale and Adams.)

CHORUS

Where is the gambler that would stake so much,—
Time, patience, treasure, on a single throw?
The cost of it,—they'll not find that again,
Either in gold or life-stuff! All their youth
Was fuel to the flame of this one work.

(Enter Adams and Hale.)

HALE

Jupiter has set now in the West. Turn North, to Lyra: point the telescope at Vega!

(The telescope moves and stops. Hale looks.)

At last! Look!

ADAMS

(He looks.)

A sharp point of light, almost dazzling in its brilliance!

HALE AND CHORUS

I hardly dare to think what this new muzzle of ours may find.
Three thousand million new-found points of light
Is only the beginning—who can know
How much by this our universe will grow?

(In her narrations between scenes, Grace appears towards the end of her life.)

Grace

He came to the mountain direct from the war—the Major! Dressed still like a soldier, and sounding as if he had just "come down" from Oxford—he knew how to impress his peers, and gain the respect and affection of his subordinates. And ladies enjoyed that Oxford touch very much!

Scene 2

(April 8th 1920. The observatory dome on Mt Wilson. Hale, Adams, Shapley, van Maanen are in conference. Hubble is in the background.)

Hale

Gentlemen! The universe is vast—indeed, one of our purposes is to determine precisely *how* vast!—but our resources, though powerful, are limited. We are here today to agree the programme of research for our new flagship, the hundred-inch Hooker. Who shall helm her, whither, and when? In simple terms, "where are we bound, fellow sailors?"

Shapley

To search the secrets of the distant nebulae,
The greatest mystery in the seas of space
What are they made of, where's their proper place?
Are they within or far beyond the galaxy?

Is "universe" another name for "galaxy"?
How far then does the galaxy extend?
Are its limits Creation's furthest end,
Or is it but an island in an endless sea?

van Maanen

My observations show the nebulae rotate,
If they were galaxies, then spinning at that rate
They'd break the speed of light; impossible! be thus
The galaxy and universe coterminous!

Adams

We "Light Men" too have looked, and see:
Slipher has shown the nebulae
Recede so fast that they must be
Far, far beyond the galaxy!

And thus the universe is vast,
And who knows where it ends at last!

Hubble

(In the background.)

Of which is right I cannot yet be sure.
I'll need more observations, many more!
I need to fathom fully what I see:
So I must classify the nebulae.

TUTTI

Shapley da capo*, with interjections by the others.*

HALE

Then it is settled. For us astronomers, unlike terrestrial sailors, the less light the better! We Light Men, Adams, are, however, content to take our spectra of the Sun and planets with even a full moon, while for you Dark Men, Shapley, van Maanen and Hubble, venturing into the furthest reaches of space, only the darkest nights will do. Anchors a-weigh, let the voyage begin!

TUTTI

Where lies the land to which the ship would go?
Far, far ahead, is all her seamen know.
And where the land she travels from? Away,
Far, far behind, is all that they can say.

Grace

The first time I saw him I was on a walk up the mountain. He was standing at a window, examining a photographic plate against the light. He was tall, strong and beautiful, with the shoulders of the Hermes of Praxiteles. There was a sense of power, channeled and directed in an adventure that had nothing to do with personal ambition.

Scene 3

(June 1920. The observatory by day. Hubble is studying a photographic plate. A Chorus of ramblers appears, Grace among them.)

Chorus and Grace

Up and up,
Along the thin white trail that winds and climbs
And zig-zags through the grey-green mountain sage,
Like ants we crawled, until the shining plain
Below it, like an airman's map, unrolled.
Houses and orchards dwindled to white specks
In midget cubes and squares of tufted green.
Up for nine miles along that spiral trail
Slowly we wound to reach the lucid height
Above the clouds, the sage-brush all died out.
Now over us, like some cathedral's dome,
The observatory looms against the sky;
And the dark mountain with its headlong gulfs
Has lost all memory of the world below.

(Exeunt ramblers, but Grace stays behind, attracted by Hubble.)

Grace

Dr Hubble, I believe?

Hubble

I am. I don't think we've been introduced?

Grace

Grace Leib. I'm a friend of the Wrights'. I've come to keep Elna company.

Hubble

Ah, the Captain and I share an interest in the nebulae!

Grace

Is that what you're looking at now?

Hubble

Oh no, this is a plate of Orion.

Grace

The lover of Eos? Say, you should come visit us all at the Kapteyn cottage; I'm sure the Captain would be glad of more knowledgeable company!

HUBBLE
It seems to me he can't lack for that; but I'd be delighted.

(Exit Grace. Night falls.)

HUBBLE

I shall sail across the sky,
I shall sail alone;
Through the deeps of space I'll fly
And make those deeps my own.

The shining skies shall be my home,
The shining skies above;
Far from the petty Earth I'll roam
And cold shall be my love.

I go forth to make my name,
I go forth alone;
I shall eclipse my teachers' fame
And bright shall shine my own.

Careful I shall chart the skies,
Careful I'll survey;
No risky jaunt, no wild surmise
Shall tempt my course to stray.

Let others chance the grand idea,
Let others chance their eyes;
I shall be slow, I shall be sure
And I shall have the prize.

Grace

Few women were allowed to be astronomers then—but women found other ways to practice astronomy! Never forget Henrietta Leavitt, the humble genius who laid the groundwork for Edwin's first breakthrough. Those grand men at the top of the mountain would achieve nothing without we women at the bottom.

Scene 4

(A cramped office at Harvard, 1911. Chorus of women computers sitting at tables, among them Leavitt.)

Chorus and Leavitt

Tutti
Drudging at our desks all day
Lecturers' work for labourers' pay
Yet from tables we have wrought
Monuments of modern thought!

Tutti (chorus)
Venus may not see the stars
Telescopes reserved for Mars
One day we shall be renowned
When the boys are underground!

Fleming
Williamina Fleming, I
Aim the stars to classify
By their spectra each I'll log
In the Draper Catalogue

Tutti repeat chorus

Cannon
Annie Jump Cannon am I
Hired to scan the southern sky
Fleming's scheme I shall refine
The Draper Medal shall be mine!

Tutti repeat chorus

Leavitt
Henrietta Leavitt, I
Measure luminosity
The Cepheid variables pulsate
According to their brightness—wait!

A Computer

(To another)

What a variable-star 'fiend' Henrietta is-one can't keep up with the roll of her new discoveries!

Leavitt

(Rising from her chair)

I can measure the miles to a star
By the light of a Cepheid candle
Just by taking its pulse I can handle
Any distance, howsoever far!

For the speed of a Cepheid's pulsation,
And the power of its illumination
Correspond! So by taking its pulse we can tell
How bright it is; if we but measure as well
How bright it looks, then it is easy to see
From the difference how far away it must be,
And thereby how far are its neighbours—
A cosmic yardstick for my labours!

(Exeunt omnes. Leavitt leaves her paper on her desk. Enter Shapley.)

Shapley

(Finds the paper and exclaims.)

But this changes everything! Miss Leavitt's Cepheids are of the fifteenth magnitude—mine of the fifth; so if they are truly similar, then the galaxy is much bigger than we thought: not 30,000 but 300,000 light years across!

(Exit Shapley. Enter Hubble, who also finds the paper and considers it carefully.)

Hubble

The truth may be grander yet!

Grace

Edwin remained always above the fray. He was at the Great Debate in Washington over the size of the universe. All the great astronomers of the day were there—and Einstein!—his rivals, Shapley and van Maanen. But Edwin bided his time—and in time, eclipsed them all.

Scene 5

(April 26th 1920. The National Academy, Washington. Chorus of astronomers and physicists at dining tables. At one table, Einstein at the head, with Hubble, Hale, van Maanen, Shapley and Curtis. At the front, an interminable awards ceremony is ongoing.)

Shapley

Some noble human antique is being honoured for his fight to eradicate hookworm!

(Aside)

And I'm waiting for my fight to secure the directorship of the Harvard Observatory.

Einstein

I have just got a new theory of Eternity.

(The awards ceremony ends. Hale rises and goes to the podium.)

Hale

And now the inaugural William Ellery Hale lecture, endowed by (ahem!) myself and my sister Martha in memory of our father, which tonight will take the form of a debate.

The universe is much bigger than we used to think, but how much bigger? Do we "merely" live in a galaxy ten times larger than we previously believed? Or is our universe in fact an unimaginably vast ocean in which our galaxy is just one island in an uncountable archipelago? The study of the mysterious nebulae has recently shed light on this question, but which way does it come down? First, to argue for the "big galaxy": Dr Harlow Shapley of the Mt Wilson Observatory.

Shapley

I used to believe the island universe theory myself, but the recent evidence from observations of the nebulae is incontrovertible:

1. Nebulae are above or below the galactic plane, but in an island universe we should expect to see them everywhere.

2. My colleague and friend van Maanen has shown that the nebulae rotate, and at such a speed that if they were extra-galactic they should be moving faster than the speed of light, which is impossible, as our friend Einstein has told us!

So, the galaxy is in fact the universe, a mighty 300,000 light years across!

Hale

And now to argue for the "island universe": Dr Heber Curtis of the Lick Observatory.

CURTIS

My colleague is persuasive, but too hasty.
1. The spirals are full of occulting matter that prevents the passage of light. Our galaxy is just such a spiral, so of course we cannot see through it to the nebulae in the same plane!
2. With the greatest of respect, my esteemed colleague van Maanen's measurements are dubious, made from photographic plates too vague to examine precisely.

(He shows an example.)

We await only the observations to prove definitively that the nebulae are extra-galatic!

HALE

Thank you gentlemen. Which way will the conundrum be resolved? And who shall resolve it? I believe the answer will not be long in coming. . .

(Shapley and Curtis start arguing, but few are paying attention.)

SHAPLEY

I am right!

CURTIS

No, I am right!

HUBBLE

(Aside)

We shall soon see!

His first great triumph was Plate H355H, the candle that would light his way to fame. Poor Shapley! Like so many of Edwin's rivals, Shapley chose his camp too early, and chose wrong.

Scene 6

(October 5th 1923. The observatory dome on Mt Wilson. Hubble at a workbench with a newly-developed photographic plate.)

Hubble

It's a nova in a nebula! Plate H355H, you will make my name!

(Looks at other plates)

But look, here it is, dimmer. . . and here brighter. . . it's not a nova, it's a Cepheid! A standard candle! The nebulae are no mere gas-clouds, but each contains millions of stars—the universe is a hundred-fold bigger than we thought!

This candle shall ignite my fame
In distant skies inscribe my name
In letters of nebular flame
Old Shapley is out of the game!

The universe grows, and I have moved it
The nebulae are extra-galactic
Curtis is right, but it's I have proved it
Light years measured with Shapley's own tactic!

(Chorus of stars repeats first verse.)

I must write to Shapley!

(He laughs maliciously.)

You will be interested to hear I have found a Cepheid variable in the Andromeda Nebula. I have a feeling that more variables will be found by careful examination of long exposures. Altogether next season should be a merry one and will be met with due form and ceremony.

(He "sends" the letter to Shapley, at the side of the stage.)

Shapley

(Reads the letter, exclaims.)

Here is the letter that has destroyed my universe. And to think he used *my* measurement technique against me!

(On this occasion only, Grace is her younger self, at the same age as in the following scene.)

GRACE

You know, I'm the one bringing money to this marriage. What I really wanted was a balancing spirit, but I didn't realize it until I saw it in Edwin, the first time I met him. But of course I was married then. And later, the way he courted me. . . he would run to my parents' house in the evening, and read to me by the fire. . .

Scene 7

(February 23rd 1924, evening. Outside the Burke family home. Hubble and Grace stand together. Later, Chorus of museum visitors, steamship passengers, tourists, dinner guests.)

Hubble

We'll be married in the morning. You know, I don't have to be an astronomer. I could practice law again, earn a decent salary.

Grace

(Laughs.)

We'll have enough money, you know that. I could not marry you if it meant you forsaking your love for the stars. Do you remember when we first met?

Hubble

Time means nothing when I think of you.

(They go into the house. Morning comes. Chorus of museum visitors. They come out again, in wedding clothes.)

Grace

Now to make our life together. . .

Hubble

How to make our life together?

Grace

You know what Bertrand Russell says.

Hubble / Grace

Creative work / Effective contribution

Hubble

It sounds as though we're trying to draft a constitution!

Grace / Hubble

Freedom of movement / Economic independence

Grace

I've got the dough and your star's in the ascendance!

Grace and Hubble

Living a full life on terms of equality with all

Chorus

Cheers! Cheers to the bride! Cheers to the bridegroom! Hooray!

HUBBLE

Come on, we've got a train to New York, then the boat from Montreal!

(New York City, Natural History Museum. The Hubbles look at a Brontosaur skeleton and dinosaur egg.)

GRACE

The finest things in New York!

(The steamship *Montlaurier*. Hubble lies miserably in his bunk. Grace attends to him, then mixes with the passengers and crew.)

HUBBLE

She mothers me, lying low in my bunk, and still finds time to captivate everyone on board from the Captain to the bugler.

GRACE

These waves! We're being tossed like bugs on a chip!

(Westminster Abbey. Poets' Corner.)

GRACE

My old friend, Samuel Johnson. I had not realised that the work of men could be invested with such awe.

HUBBLE

Newton! Herschel!

(The Criterion Restaurant, Piccadilly. Royal Astronomical Society dining club dinner.)

PRESIDENT

A toast to Hubble and Mrs Hubble!

CHORUS

Hubble and Mrs Hubble!

PRESIDENT

And Hubble, you're famous in England now—you were mentioned recently in *Punch*!

CHORUS

Hubble Bubble!

(Florence, an apartment in the Palazzo Vecchio. The Hubbles enter a suite.)

HUBBLE

When we build our house, let's have it something like these rooms.

Grace

My husband had a boatload of rivals and a handful of collaborators, but only one Milt Humason. He was Edwin's support in the only place I couldn't be: on the mountain.

Scene 8

(1919–1931. The Observatory, Mt Wilson. Enter Humason, carrying a cougar draped over his shoulders and holding a .22 rifle. Small chorus of correspondents and student astronomers, including a Journalist and Benioff.)

Humason

A mountain lion got Dowd's goat
So Milton went a-hunting
And now I have a lion's skin
To wrap up Baby Bunting.

The lion was a monster beast
More than a hundred weight
From tip of nose to end of tail
She measured five feet eight.

Astronomers are very brave
To work up here all night
With lions roaming all around
Most folks would faint with fright!

They're brave allright but then we're sure
They'll all be glad to note
No more will roam around the dome
The beast that got Dowd's goat!

Journalist

Milton? Milton Humason? I'm from the *Los Angeles Times*. How did you come to kill this fine beast?

(While Humason tells the story, the Journalist takes photos.)

Humason

My father-in-law, Chief Electrical Engineer Merritt C. Dowd, keeps goats on the mountain, and this lion was a-feasting on the goats. So I set up a steel trap with its latest kill. This morning I went down to the trap. No use! Suddenly, looking up, I found myself looking right into the angry eyes of the crouching lion! I didn't even think, I just shot it, and it dropped dead at my feet.
Say, are you going to put my photo in the paper?

Benioff

(Wanders over.)

You like photography? Want to learn how to do it?

Humason

Sure!

(Humason follows Benioff offstage. The others disperse, and exit. Humason and Benioff return, discussing a plate. Enter Shapley.)

Benioff

Dr Shapley, sir? My stay here's nearly up, so I wanted to let you know: this man should be my successor. I've taught him everything I know about photography this summer!

Shapley

So, Humason, you've been studying? Looking to better yourself, eh?

Humason

Well sir, after I shot that cougar I thought, maybe I should be looking for bigger game; why not shoot stars!

Shapley

(Laughs.)

Very good! We'll have to find you a hunting partner. . .

(Exit Benioff and Humason. Enter Hale, who goes to talk to Shapley, and, from the opposite side, Hubble.)

Hubble

Hale, Shapley. I need an assistant. I'm ready to analyse the most distant nebulae the Hooker can see; but I'll need help with the plates.

Shapley

And I have the perfect candidate! You know Milt Humason?

Hale

(Doubtful.)

The janitor?

Shapley

Humason! Get over here, there's someone I want to introduce you to! Hubble, this is Milton Humason; you remember he shot that cougar? Well, he's been learning photography with Benioff and now he wants to shoot stars! Milt, Dr Hubble here was just telling me he needs an assistant.

HUBBLE

Are you ready for an adventure in the farthest reaches of space, among the clusters of the most distant nebulae? We can't use individual stars as our guides that far out, we'll have to develop a method to compare whole nebulae, the brightest in each cluster. It'll be hard work: several long nights for just one plate. But I think we can show that the fainter the nebula, the farther it is—and the more redshifted!

HUMASON

(Baffled, but delighted.)

I'm in!

HALE

Well, I guess that settles it. Humason, as of now you're an Assistant Astronomer.

HUMASON

Thank you, sir!

(Humason and Hale shake hands. Exit Hale and Shapley. Hubble and Humason ascend to the viewing platform and spend some time observing, then descend, jubilant, with a sheaf of paper.)

HUBBLE

We've done it! Nearly a hundred nebulae photographed, thanks to you, Milt, and they're all pointing the same way: away from us! "The Velocity–Distance Relation Among Extra-Galactic Nebulae", Hubble and Humason! The speed of recession, as measured by the redshift, is proportional to distance. Hubble's Law!
At last, my law!
I hold the floor;
Amongst my peers I'm listened to:
Associate of the Royal Astronomical Society,
Elected youngest member of the National Academy,
And Chairman of the Nebulae Commission of the IAU!

Redshift is proportional to distance,
Reputation is proportional to fame;
For all those long and freezing nights
I peered at tiny distant lights
Taking all those blasted plates that look the same,
And now at last they recognize
Me as the Sailor of the Skies
And on every hand I'm greeted with acclaim!

CHORUS

Now at last they recognize
The sailor of the Skies!

Grace

Of all Edwin's victories, the greatest was not to triumph over a vanquished foe, but to win over a most illustrious friend: for him, Mohammed came to the mountain. Einstein himself!

Scene 9

(11th January 1933. The observatory dome, Mt Wilson. Lemaître and Einstein enter from opposite sides of the stage.)

Lemaître

Herr Einstein! Aren't you expected at the seminar on theoretical physics?

Einstein

Abbé Lemaître! I am, but I must discuss with you further your ideas that you have so brilliantly expounded today. Your Primeval Atom Hypothesis is the most beautiful and satisfactory explanation of creation to which I have ever listened. But I cannot accept it!

Lemaître

I thank you for your kind words, but what difficulties do you find with my theory?

Einstein

It is too theological! I cannot accept an initial singularity, a beginning to the universe.

Lemaître

Too theological? But you believe the universe is infinite?

Einstein

It seems the most likely probability.

(They walk slowly away from each other; Lemaître returns to centre stage.)

Lemaître

But the singularity is just the universe's natural beginning; that is not the same thing as Creation, you know! *It appears to me that there are two paths to truth, and I try to follow both of them. As a priest I follow the path to salvation, but as a scientist I follow the narrow way to scientific certainty. The scientist must always steer between the myopic positivism that cannot go far beyond the experience, and the dreamy idealism that loses any contact with it.*

(Einstein returns to centre stage.)

How could human thought comprehend an infinite universe?

Einstein

You are right, my friend. We must hear what the astronomers have to say.

Lemaître

You mean Hubble?

Einstein

I do.

Lemaître

We all have to listen to Hubble. His word becomes law. . . you know I published on the velocity–distance relationship, "Hubble's Law," two years before Hubble? But no-one paid any attention, except you. . .

(Exeunt omnes.)

Grace

I never understood how van Maanen was able to get away with his shoddy observations for so long. His spurious claims delayed Edwin's deserved recognition by years! He deserved a worse disgrace, the charlatan!

Scene 10

(1933. The observatory dome, Mt Wilson. Night. Enter van Maanen, holding a notice, which he affixes to a piece of equipment.)

van Maanen

There! That will get Hubble's goat. It was my turn to sit at the head of the dinner table: I am the observer at the hundred-inch tonight! Hubble switched our napkin rings before dinner, the lout! When we came in to dine, I had to take his place, and he took mine. The humiliation!

(Van Maanen ascends to the viewing platform. Enter Hubble.)

Hubble

Van Maanen will not share his plates! "If it were not for van Maanen's measurements, Hubble's results might be accepted," they said at the Royal Astronomical Society. How can I contest his measurements if I cannot see his plates?

(Calls up to the viewing platform.)

Van Maanen! May I consult your plates, to check the rotation?

van Maanen

No!

Hubble

Then I shall have Humason take new plates!

(Spots the notice van Maanen put up.)

What's this?

van Maanen/Hubble

Tonight is mine, sir, be good and run along. /
The jig is up, sir, your measurements are wrong.
You've no respect, sir, I won't cooperate. /
You know quite well, sir, that they do not rotate.
The worst insult, sir, I've had in my career! /
It's over now, sir, the end is drawing near.
You may taunt me, sir, you'll never see my plates. /
I'll make my own, sir, my destiny awaits!

(Van Maanen retires to the telescope. Enter Adams.)

Adams

What's all the fuss? Someone said you two were having a row.

Hubble

Van Maanen won't let me see his plates! He knows his measurements are wrong, but he...

ADAMS

(To Hubble, exasperated.)

Desist at once, sir, from this impertinence.
Why yet again, sir, your pride outruns your sense.
Can you not see, sir, you've everything to gain?
If you'll but wait, sir, you'll triumph once again.

(Hubble hurries off. Adams follows, slowly.)

Grace

Of all the illustrious visitors we have had, famed for their brilliance, their wit, or their beauty, I never felt so close to any of them as I did for one brief moment to a cloth merchant's daughter who married her cousin: Elsa Einstein.

Scene 11

(4th February 1931. Afternoon. The observatory dome, Mt Wilson. Enter Einstein, Elsa, Hubble, Grace, Adams and Tolman. Einstein and Tolman are in conversation.)

Tolman

I hear from Lemaître that you don't like his expanding universe.

Einstein

I do not like its implications, Tolman. But maybe I will have to accept it.

Tolman

It certainly clarifies the mathematics. But what clinches it for me is the evidence from this marvellous instrument. You've seen Hubble's plates showing the redshift?

Einstein

Yes. And later I believe we are to have a demonstration of the "marvellous instrument".

(A Photographer enters. Adams motions everyone into a group. Hubble manoeuvres himself so that he, not Tolman, is next to Einstein.)

Hubble

(To Elsa)

You know, Frau Einstein, the Hooker telescope is essential for determining the universe's structure.

Elsa

Well, well, my husband does that on the back of an old envelope. Yes, on the back of an old envelope.

Einstein

(To Grace)

Your husband's work is beautiful.

Grace

(Touched by the flattery.)

How kind of you. You both must come and have dinner with us.

(The Photographer takes the picture, packs up and leaves. Night falls.)

Adams

And now, gentlemen, if you'd care to ascend to the viewing platform, where we shall be setting our sights on Sirius this evening. Professor Einstein, I believe the Dog Star has a special significance for you?

EINSTEIN
Indeed, it was a key witness to the Theory of General Relativity!

(The men ascend to the viewing platform and each in turn looks through the telescope.)

GRACE
What a relief!

ELSA
(Looking tired)
Yes, what a relief.

GRACE
It's harder away from home.

ELSA
I fear one day we will not be able to go home any more.

GRACE
At least we have these moments: they're safe in their own world, and we can be friends.

ELSA
Thank you, Mrs. Hubble.

GRACE
Come on Elsa, let's find something to eat.

(Exit Grace and Elsa. Einstein descends, alone.)

EINSTEIN
Mine and de Sitter's static universe
Is blown apart by Hubble's shift to red
And now I've seen the nebulae disperse
The cosmological constant is dead:

Lemaître and Tolman's theory now combine
With Humason and Hubble to refine
My relativity: now less mundane
Than the tame wishes of my pious brain!

Truly this telescope's a wondrous Eye:
Even the mind of God it can descry!

(As he finishes, the rest of the party descend, and all exit.)

Grace

I wish now I'd kept a journal during the Einsteins' visit—now I mostly remember only little things. But I haven't forgotten the first dinner at the new Athenaeum, the only time in our lives we dined on the radio!

Scene 12

(January 15th 1931. The Athenaeum, Pasadena. Einstein, Elsa, Hubble, Grace, Adams, Tolman and chorus of diners.)

Chorus

The Athanæum's open!
We lucky few are here
But millions by their radios
Partake of our good cheer.

Only three hundred places!
A most exclusive feast
Th'Academy are out in force
From Einstein to the least

Except poor Hale, whose sick-bed
The wireless waves will reach
(The room's festooned with microphones)
But hush! here comes the speech!

Einstein

Dear friends, I account myself exceedingly fortunate to be able to break bread with you here in joyous mood. The work of all you physicists, mathematicians and astronomers here tonight has been nothing short of epoch-making! But I would like to single out Professor Tolman's use of the distance measurements. I would also like to single out Doctor Hubble's work on redshift to formulate a new, dynamic conception of the spatial structure of the universe. I am truly humbled by this revolution in our understanding.

(Cheers, applause.)

Diner

Hooray for Einstein!

Chorus

Hip hip hooray!

Diner

Hooray for Tolman!

Chorus

Hip hip hooray!

Diner

Hooray for Hubble!

CHORUS

Hip hip hooray! Hip hip hooray! Hip hip hooray!

Hooray for the expanding universe!
The skies a-brim with spinning nebulae;
Mount Wilson's eyes the inky gulfs traverse
From Sun to star to dim infinity.

As fades the fire to deepest red
Let it be said, let it be said:

Hooray for all the pioneers
Who sail the lonely seas of space
Surveying the remote frontiers,
So that our knowledge grows apace.

And that goes double
For Edwin Hubble
The bravest of the mariner race!

Hooray! Hooray!

GRACE

Oh Edwin! Sometimes I think it was only after you died that my real work began. I'll make them name the Large Space Telescope after you yet!

Scene 13

(August 1949. Downstage: St Mary's Hospital, Grand Junction, Colorado. Hubble lies propped up in bed, with Grace sitting next to him. Upstage: the 200" Hale Observatory dome, Palomar.)

Hubble

But now I see three stages in our life.
At first, we bask contented in our sun
And take what daylight shows us for the truth.
Then we discover, in some midnight grief,
How all day long the sunlight blinded us
To depths beyond, where all our knowledge dies.
That's where men shrink, and lose their way in doubt.
Then, last, as death draws nearer, comes a night
In whose majestic shadow men see God,
Absolute Knowledge, reconciling all.

Grace

But darling, you have so much still to do!

Hubble

In two years, I shall have determined the redshift, with the 200". I'm rather proud of the part I had in designing that. But the big cosmological program I shall not live to see.

Grace

And your atlas of the nebulae?

Hubble

Sandage will finish it.

Grace

I'll make sure he does!

Hubble

Though I suppose they'll call it an atlas of galaxies when I'm gone. The *Hubble Atlas of Galaxies*!

(As Hubble muses, a Chorus of stars appears in the sky and starts to echo him. The great telescope rises into the sky, becoming the Hubble Space Telescope.)

I see beyond this island universe,
Beyond our sun, and all those other suns
That throng the Milky Way, far, far beyond,
A thousand little wisps, faint nebulae,

Hubble (Continued)

Luminous fans and milky streaks of fire;
Some like soft brushes of electric mist
Streaming from one bright point; others that spread
And branch, like growing systems; others discrete,
Keen, ripe, with stars in clusters; others drawn back
By central forces into one dense death,
Thence to be kindled into fire, reborn,
And scattered abroad once more in a delicate spray
Faint as the mist by one bright dewdrop breathed
At dawn, and yet a universe like our own;
Each wisp a universe, a vast galaxy
Wide as our night of stars.

Grace

(During Hubble's speech)

Nearer to the gods no mortal may approach, O Mariner of the Nebulae!

The End

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